

No-till farming: A viable option for sustainable agriculture in the black soil region of Northeast China

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February 6, 2024



Outline



Black soil degradation in NE China



Is no-till farming a viable option for curbing soil degradation?



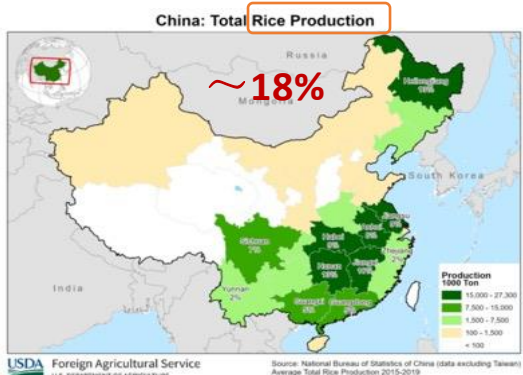
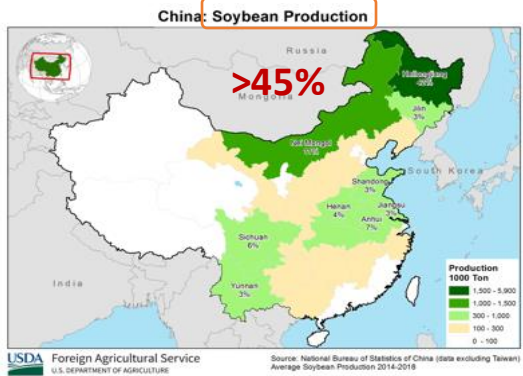
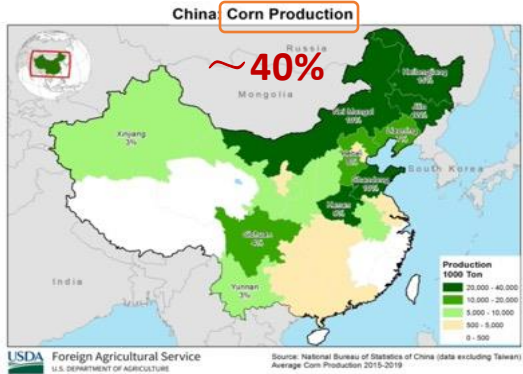
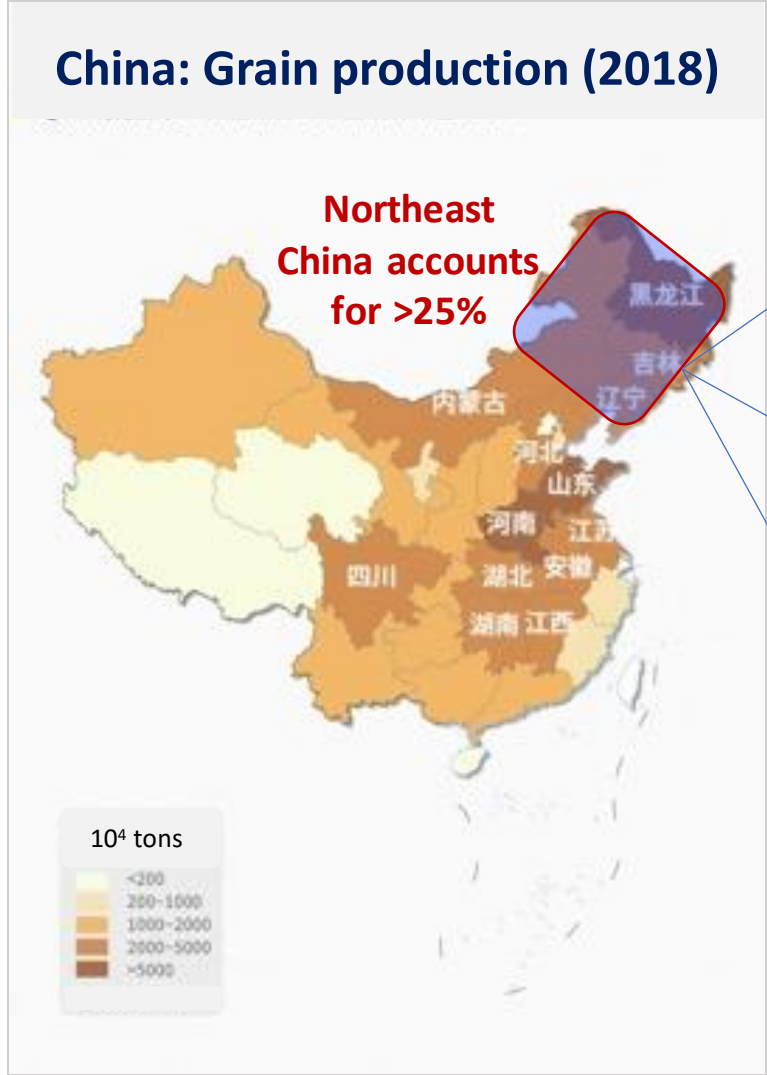
Is no-till farming accepted by farmers and policy makers?



1. Black soil degradation in NE China



Black soil region:
China's agricultural powerhouse



Soil degradation threatens agricultural sustainability in NE China

Shallower A horizon

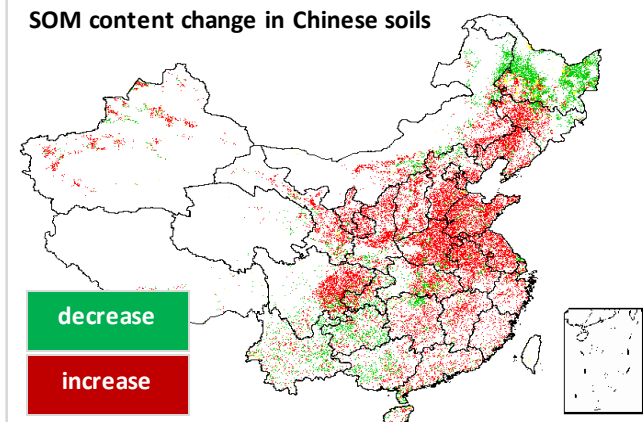
- 80-yr ago 50-100 cm
- Today 15-50 cm
- Loss rate ~2 mm/yr



Poorer fertility

SOM: lost 50% in 60 yr

- North: 3.6-4.3%
- South: <2%



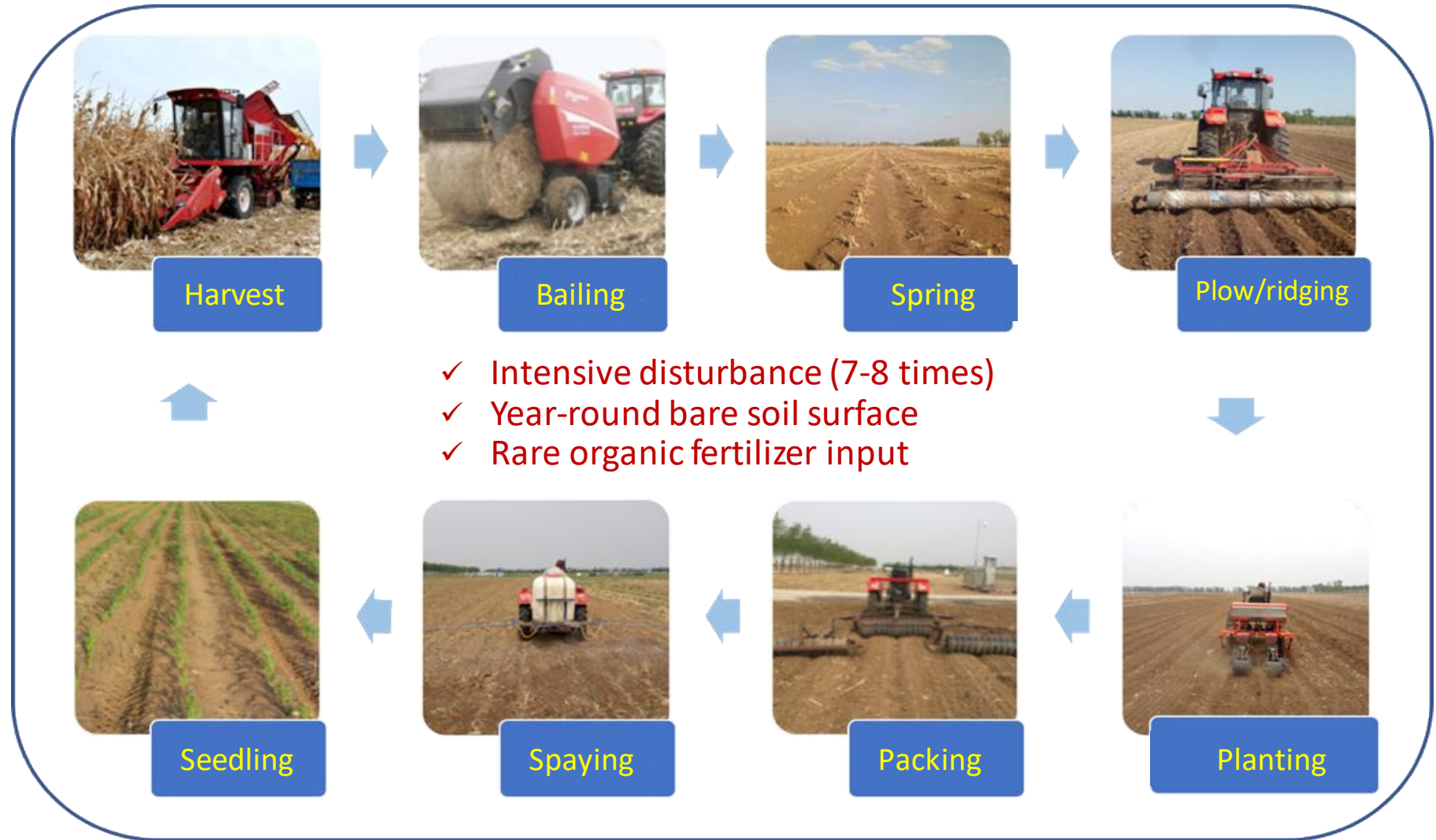
Soil compaction

Bulk density (g cm^{-3})

- 80-yr ago: 0.9-1.2
- Today: 1.3-1.5



Intensive farming system is the driver of black soil degradation



Large amounts of nutrients are taken out of soil each year (crop yield : 10-15 t ha⁻¹).



Intensive tillage destroys soil aggregates, breaks down organic matter.



Chemical fertilizers have replaced manure, a traditional practice to improve fertility.



Soil erosion removes the fertile black layer

Soil loss due to water erosion: 12-35 t ha⁻¹ yr⁻¹



Soil erosion
removes
the fertile
black layer



Straw burning in the fall



Wind erosion : 7-8 t ha⁻¹ yr⁻¹



2. Is no-till farming a viable option for curbing soil degradation



No-till farming system

- ① Corn-soybean rotation
- ② Year round surface cover
- ③ Direct seeding & fertilizer application
(Disturb soil ~3 times)
- ④ Integrated pest control



Harvest



Fall, spring



No-till planting



Late stage

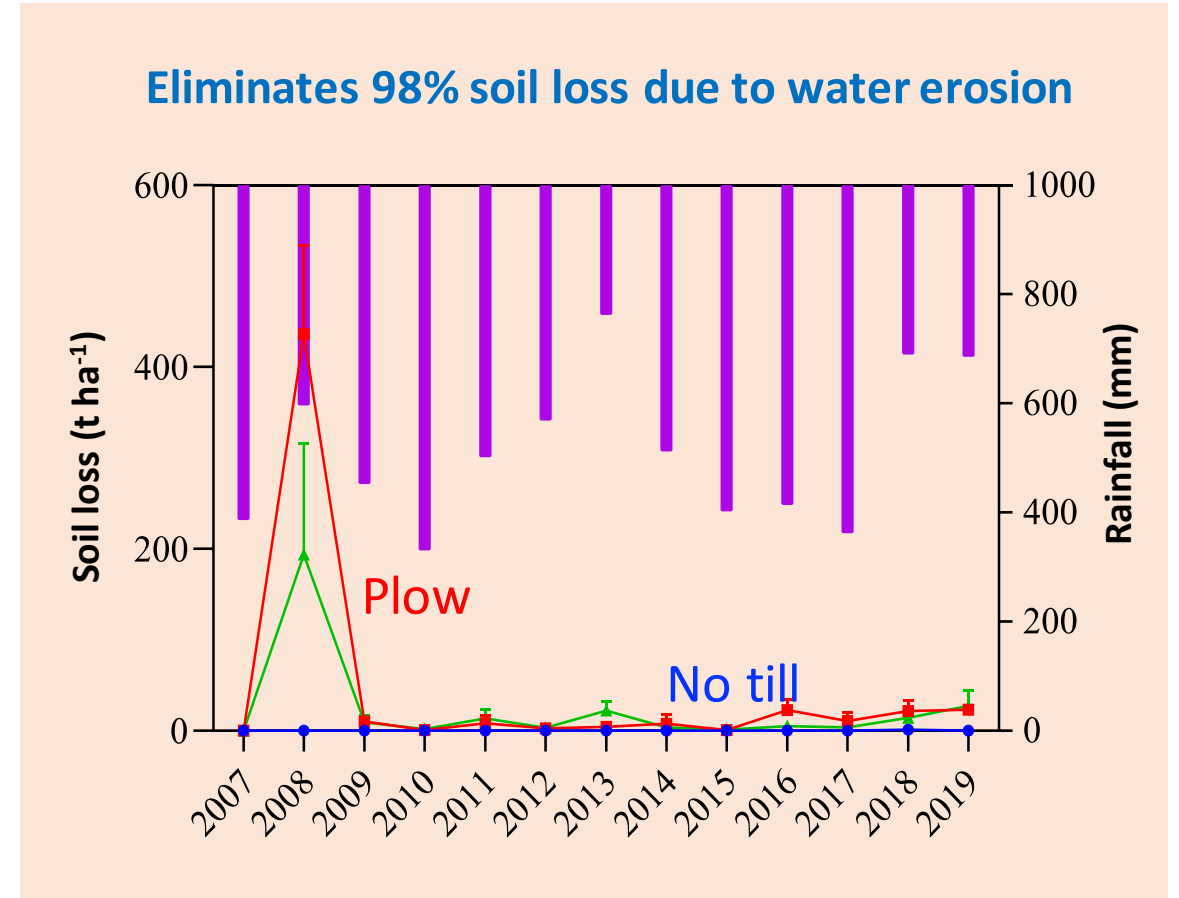
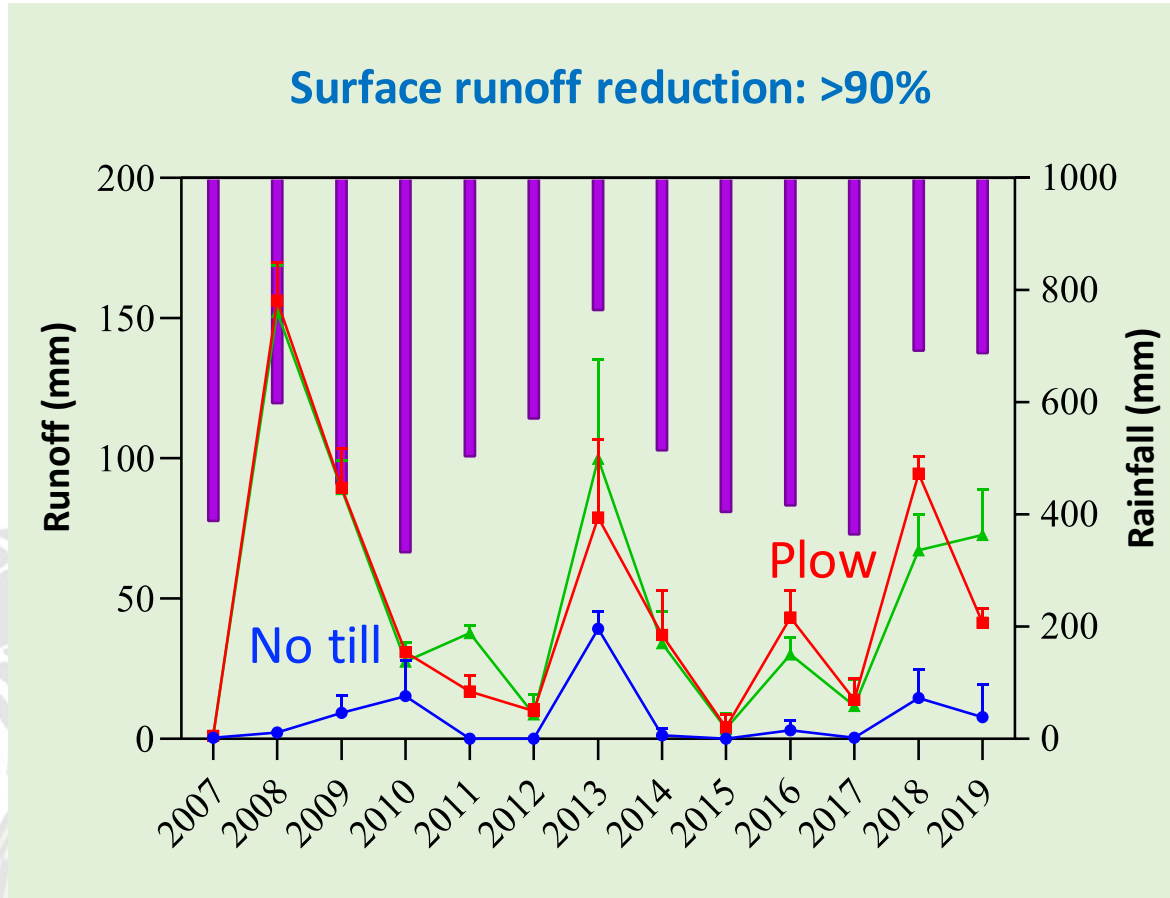


Seedling stage



Spay herbicide

Does no-till farming protect soil from water erosion?



Source: Xiyang Zhang, CAS

Webinar series | SUSTAINABLE MANAGEMENT OF BLACK SOILS



Does no-till farming protect soil from wind erosion?

- ✓ Surface coverage: 40~80%
- ✓ Soil disturbance: <20%
- ✓ High soil water contents

No-till



Strip tillage

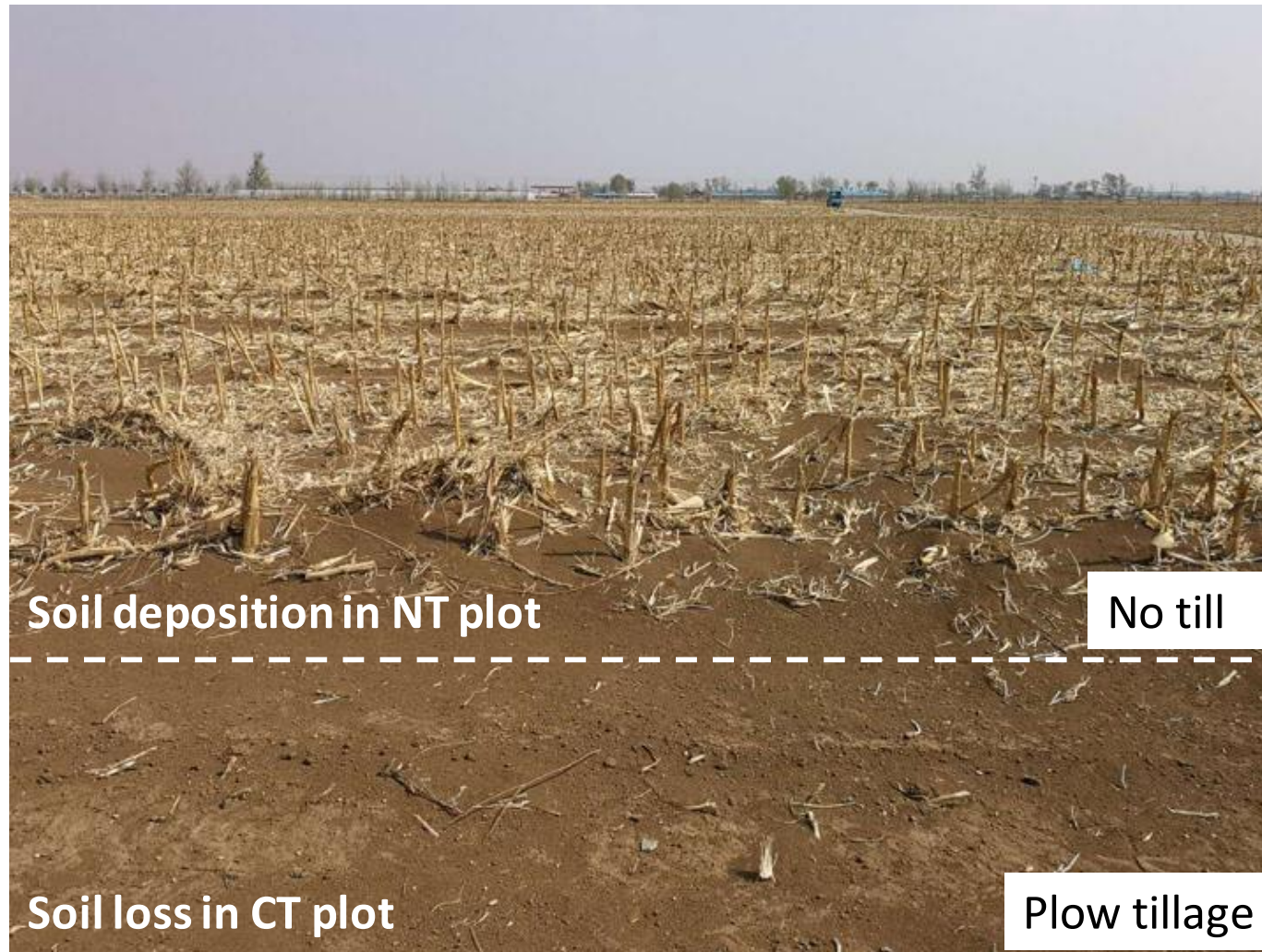


Plow tillage

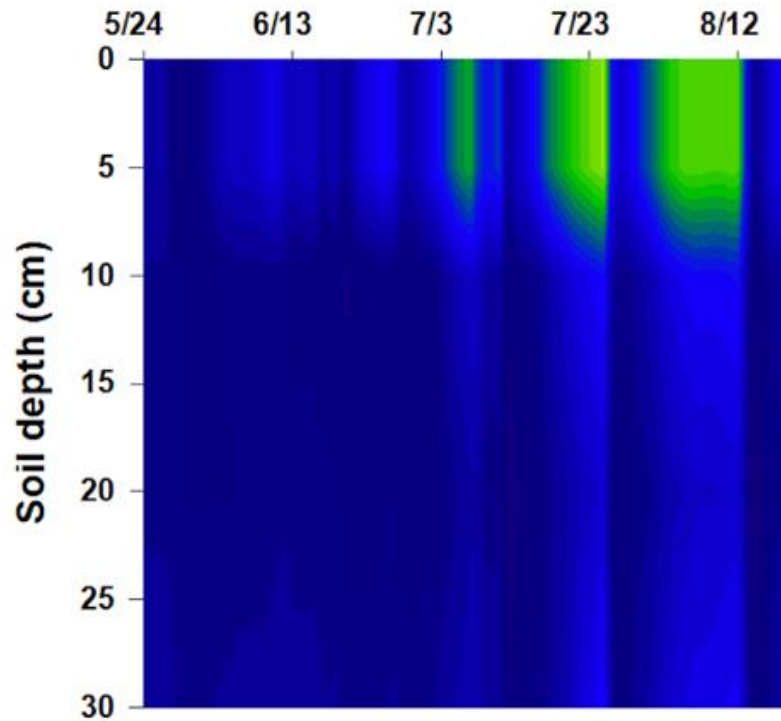


Lishu county, April 23, 2022

No-till farming significantly minimizes soil loss due to wind erosion

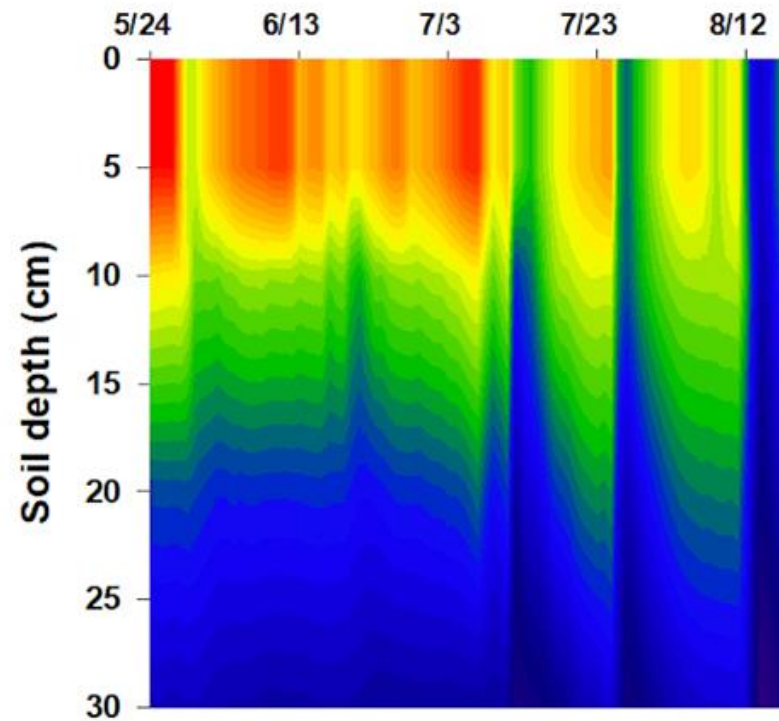


Does no-till farming soil store more water?



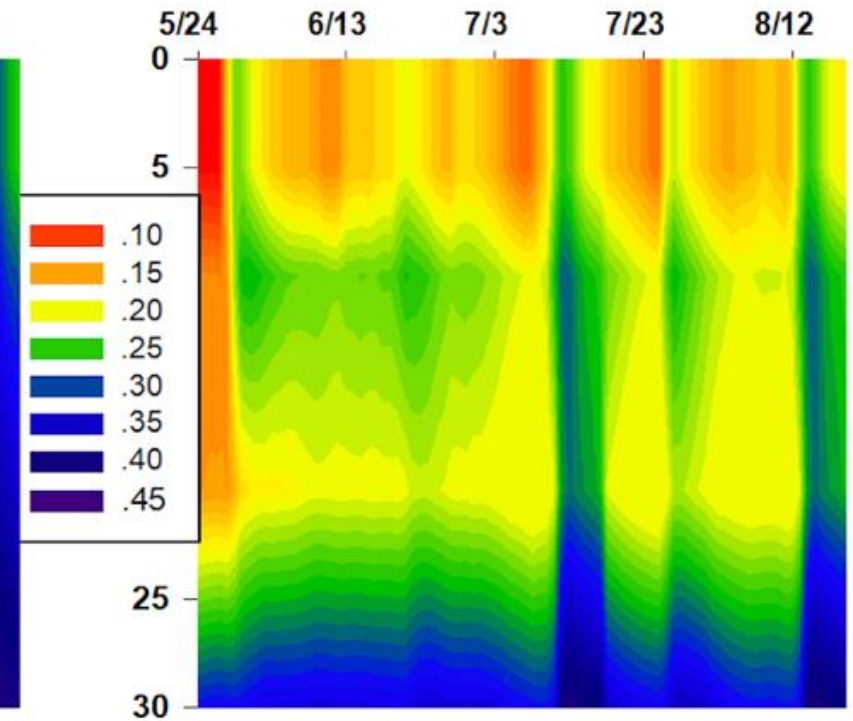
No till

No apparent water deficit



Rotary tillage

Frequent droughts, esp. in early season



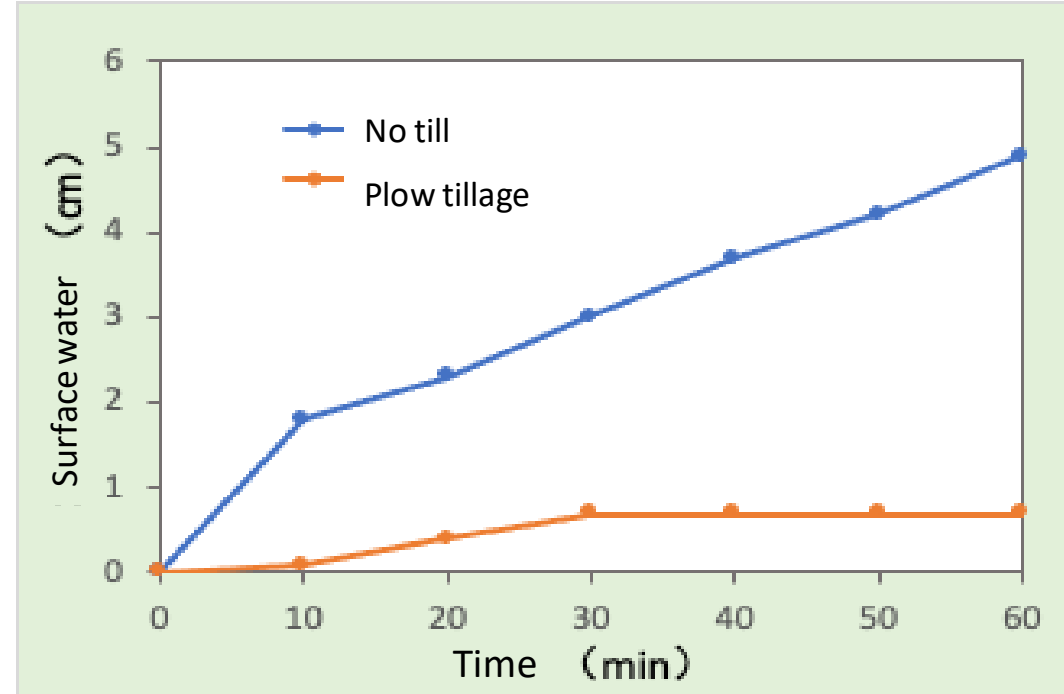
Rotational tillage

Some droughts, deep-soil water loss

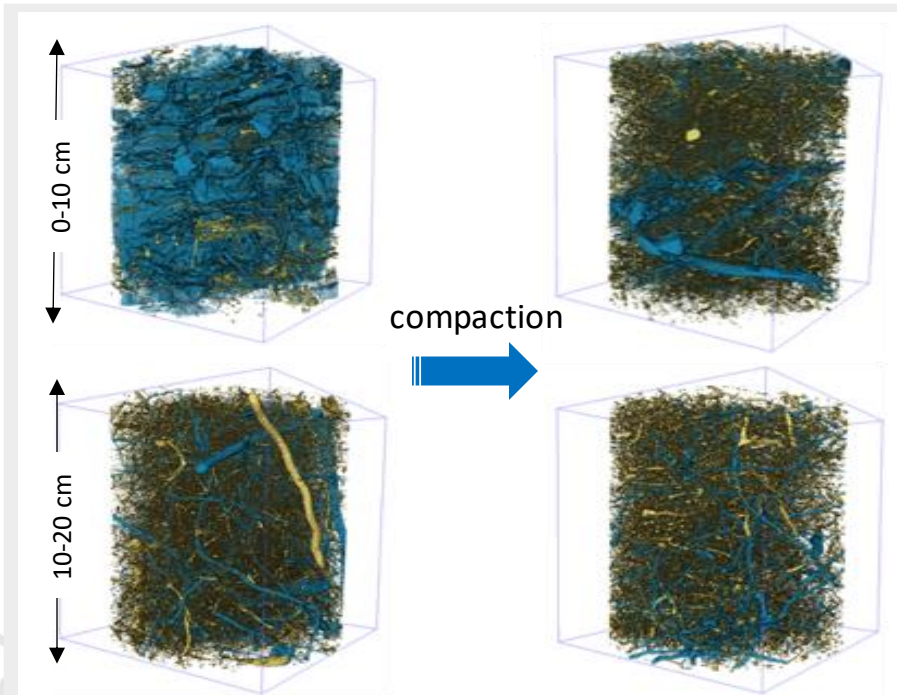
Does no-till farming reduce soil water infiltration?



No-till farming enhances soil water infiltration, mainly due to the larger fractions of biopores.

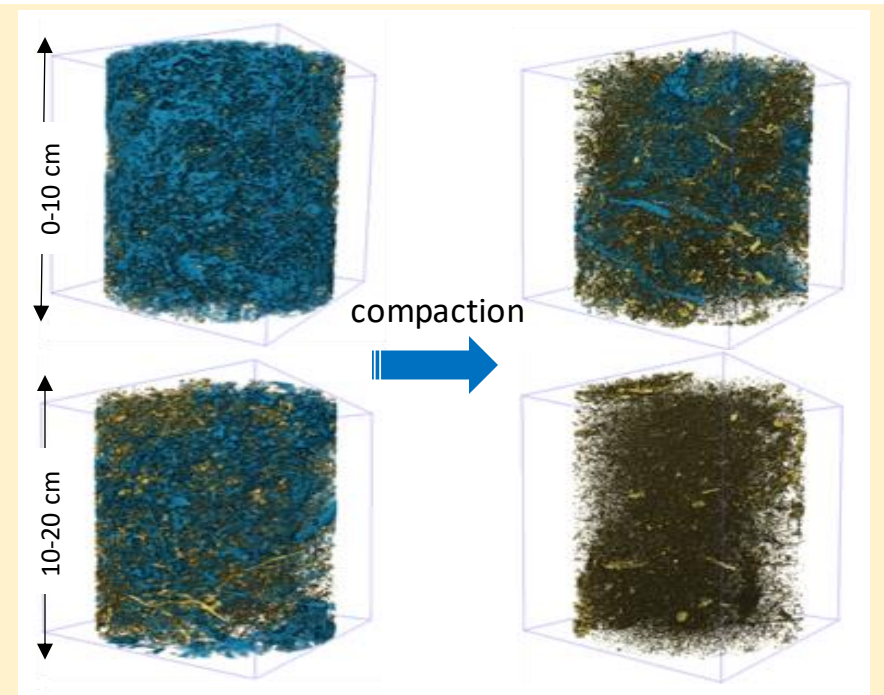


Does no-till farming lead to poor soil structure?



No-till soil

Many biological pores (root channels & earthworm holes) with high strength & good connectivity.

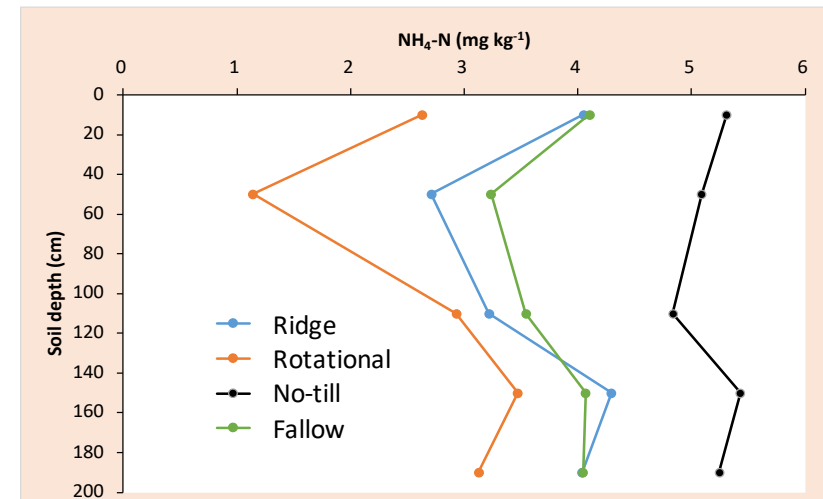
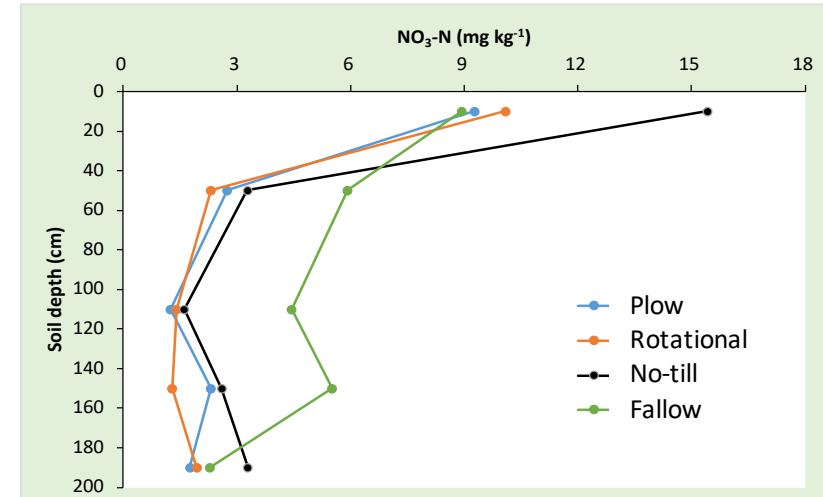
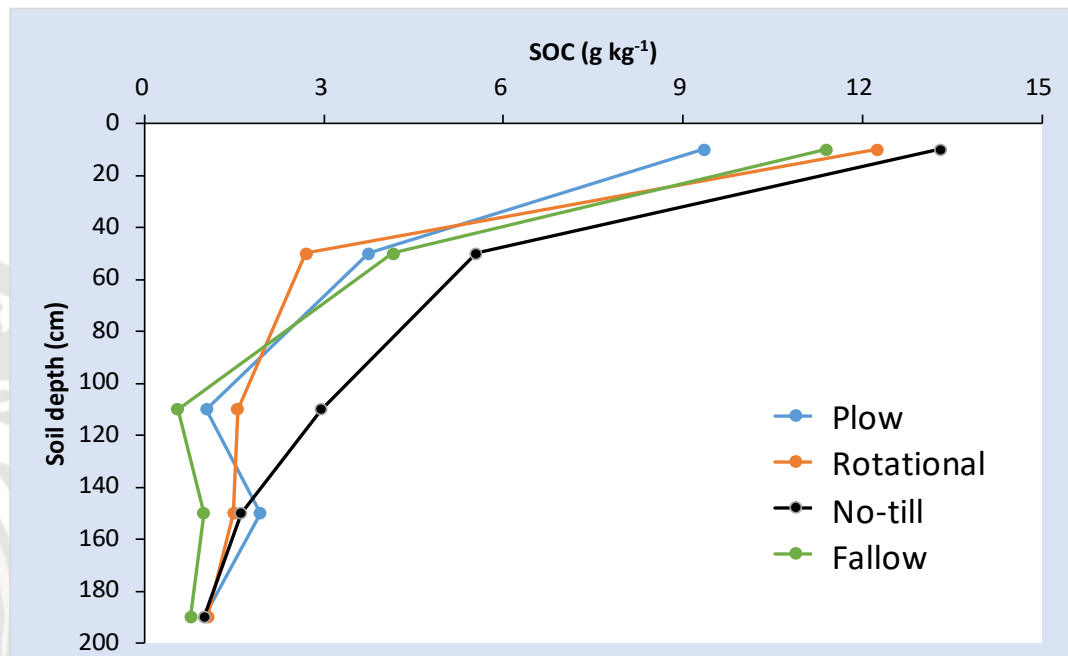


Plowed soil

Soil structure is destroyed: many small pores with low strength and poor connectivity.

Does no-till farming improve SOM content & soil fertility?

- SOC: increased by 1.92-2.95 g kg⁻¹
- NO₃-N: increased by 0.36-0.65 mg kg⁻¹
- NH₄-N: increased by 0.47-0.70 mg kg⁻¹



Does no-till farming soil inhibit crop root growth?

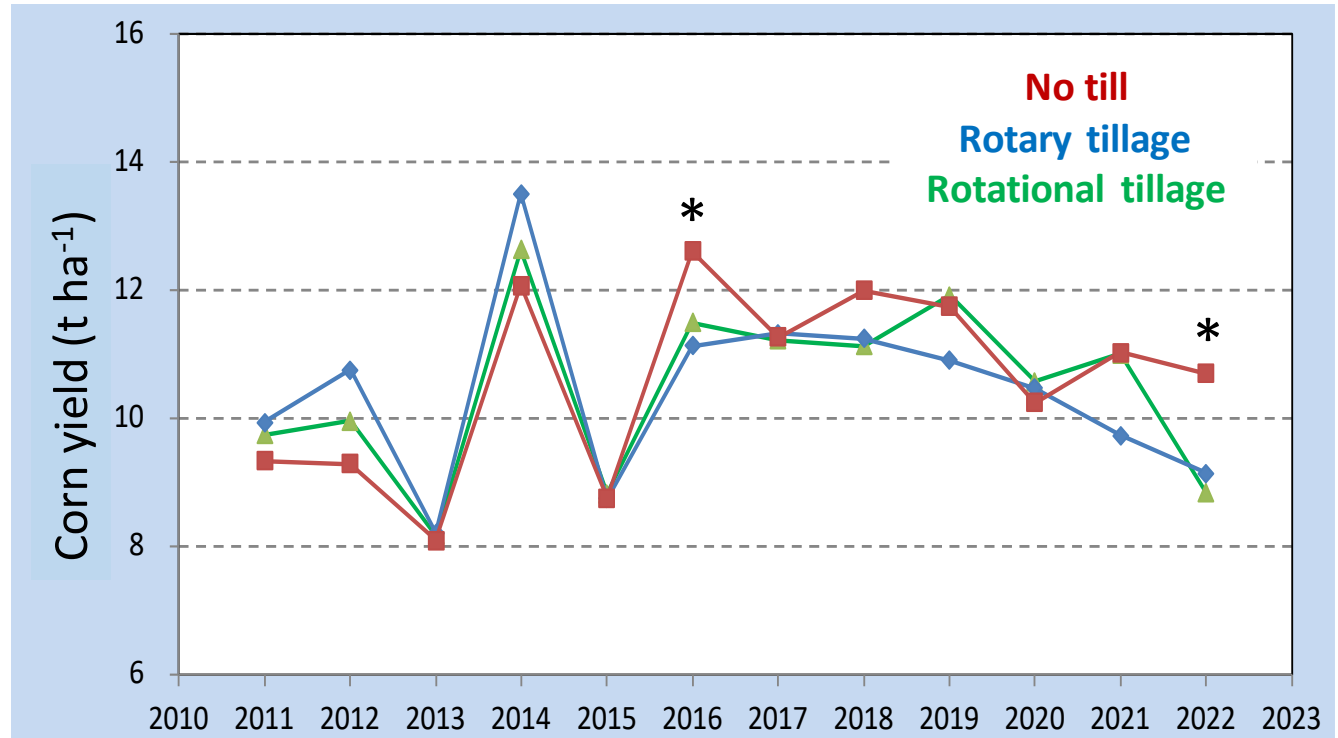
Long-term no-till farming produced a favorable soil structure that enhances root growth.



Corn root distribution as affected by tillage methods after 15 years

Does no-till farming lead to reduced crop yield?

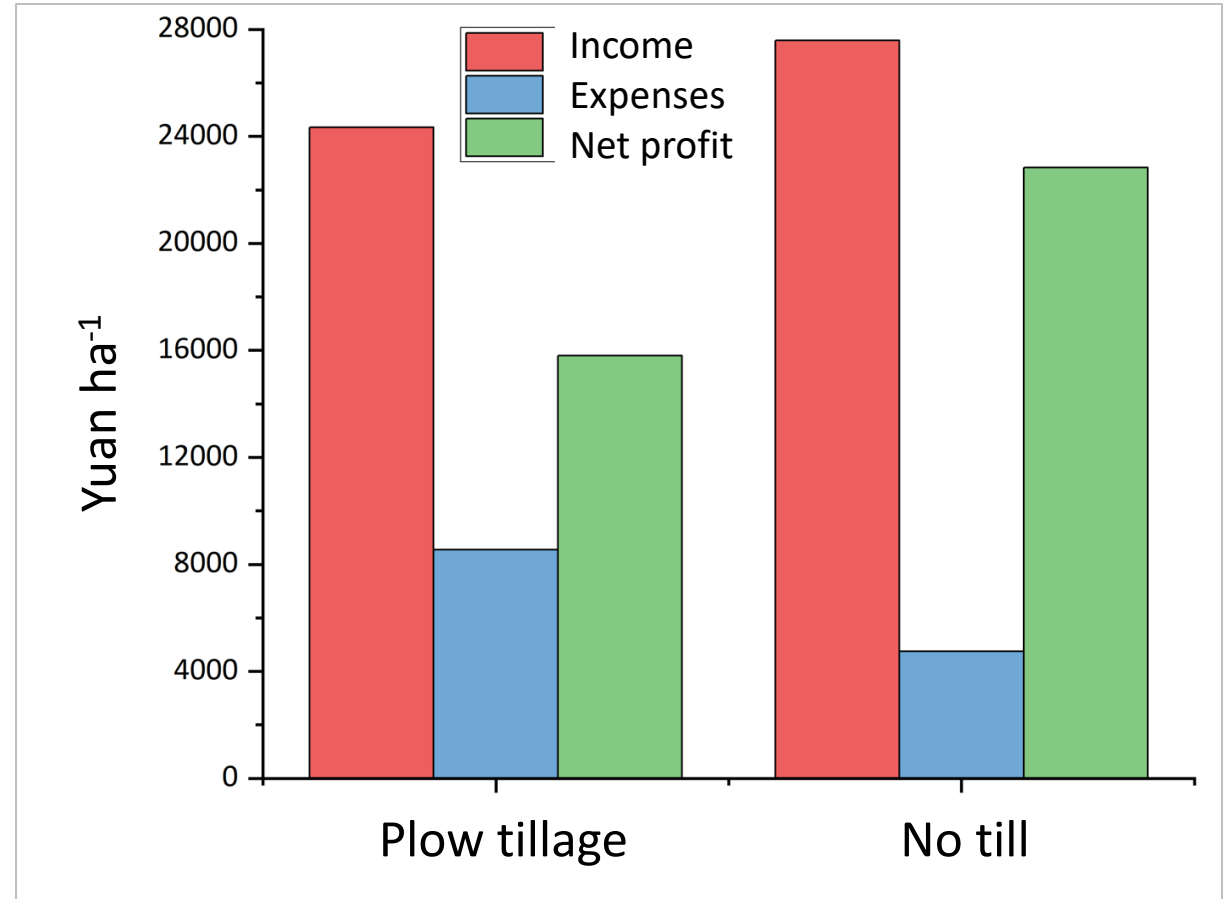
- 0~4 year: compatible or slightly lower yield;
- >4 years: compatible or higher yield;
- Significant yield (~10%) benefit in dry years



Is no-till farming profitable?

	No till	Plow tillage
Expenses	4,750	8,550
Income	27,580	24,350
Profit	22,830	15,800

- Less expenses: **3,800** yuan ha⁻¹
- Higher income: **3,230** yuan ha⁻¹
- Greater profit: **7,030** yuan ha⁻¹



Is no-till farming system more resilient to extreme climate?

- 2022: drought in spring, waterlogging in summer and fall;
- Better crop under no till system, yield increased by 17%.

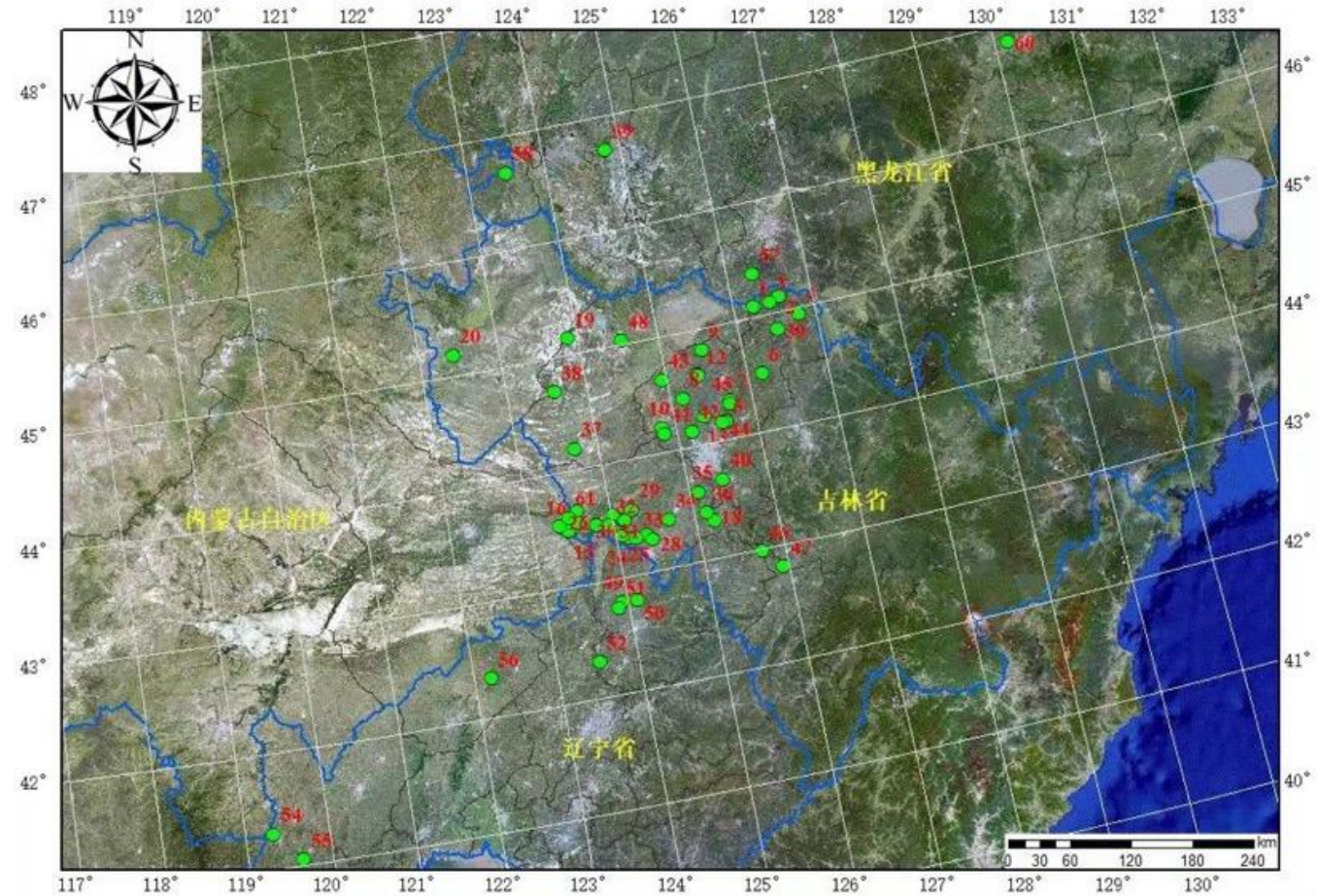


3. Is no-till farming accepted by famers and policy makers?



Field demonstration and technology transfer

- ✓ Established the “Black Soil Conservation and Management Union”, including >100 cooperative farmers across the region.
- ✓ No-till farming system is transferred by means of farmer training, field demonstration, technical service.



More than 40,000 sets of no-till seeders are being used.

Debang Dawei



Jilin Kangda



In cold regions, strip tillage has been developed to overcome low soil temperatures under no-till.



National programs have been established to promote conservation tillage in NE China.

Black soils, the “Giant panda of arable land”, should be well protected by using conservational farming systems.



农业农村部 财政部 文件

农机发〔2020〕2号

农业农村部 财政部关于印发《东北黑土地保护性耕作行动计划（2020—2025年）》的通知

内蒙古自治区、辽宁省、吉林省、黑龙江省人民政府：

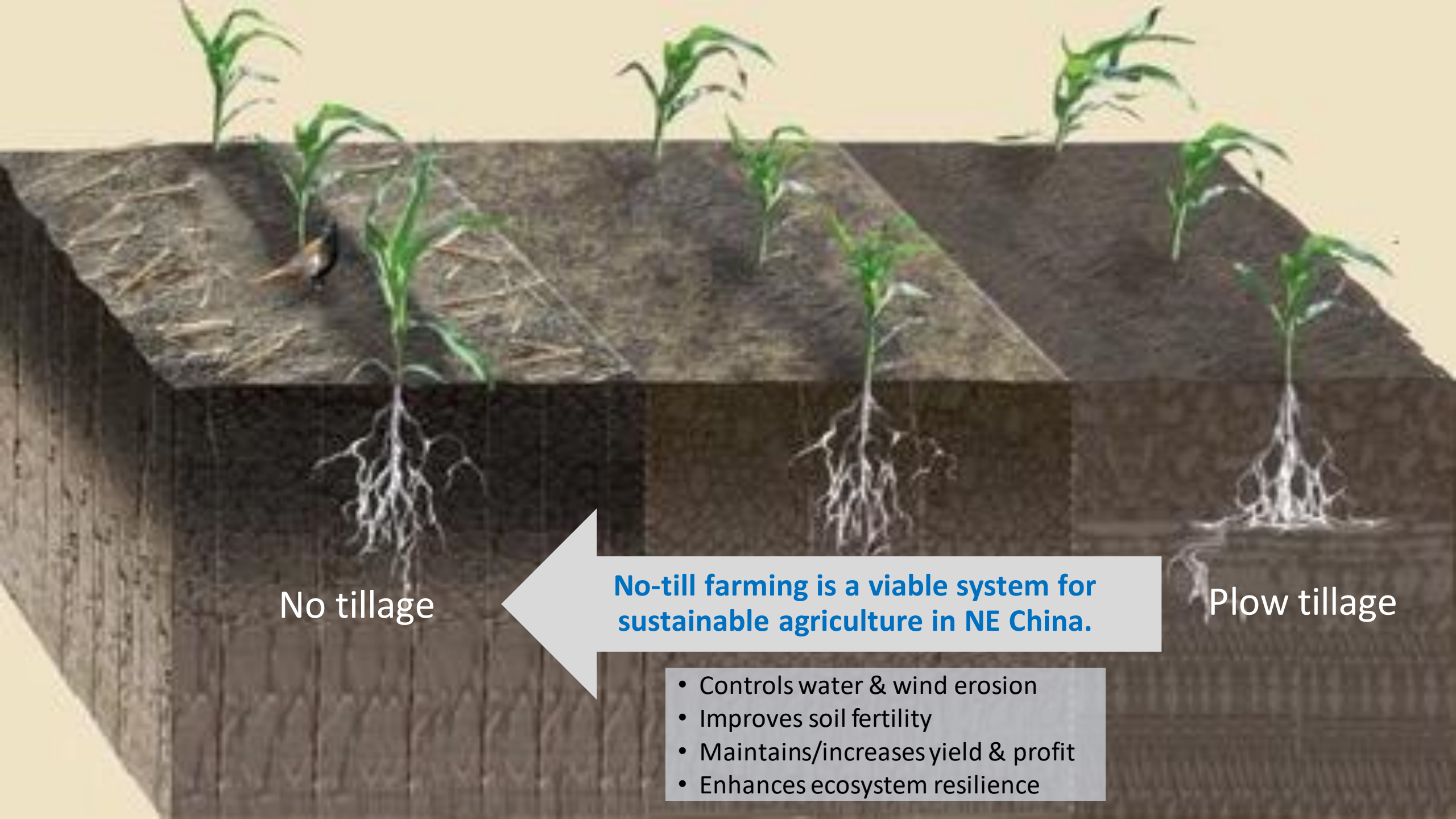
经国务院同意，现将《东北黑土地保护性耕作行动计划（2020—2025年）》印发给你们，请认真贯彻落实。

农业农村部

财政部

2020年2月25日

Conservation Tillage Action Plan for the
Black Soil Region of Northeast China



No tillage

No-till farming is a viable system for sustainable agriculture in NE China.

Plow tillage

- Controls water & wind erosion
- Improves soil fertility
- Maintains/increases yield & profit
- Enhances ecosystem resilience

**Thanks for
your
attention!**



Webinar series | SUSTAINABLE MANAGEMENT OF BLACK SOILS

